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ABSTRACT

This paper summarizes the results of a recent study of the past performance and future prospects of the International Telecommunications Satellite (INTELSAT) Organization. First, an overview of INTELSAT's history is provided and major policy issues are detailed. Five alternative paradigms are then presented through which to evaluate INTELSAT's past behavior, present challenges, and future prospects--i.e., functionalist theory, cooperation and social economy, political economy of deregulation, collective or public goods model, and neoclassical economics. Finally, eight recommendations are made in the interest of assuring INTELSAT's growth and financial viability into the 21st century. (26 references) (EW)

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Conceptual Paradigms and Empirical Investigations for Evaluating INTELSAT's Past Performance and Future Prospects

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1. Introduction

The aim of this paper is to present in summary form the results of recent research by the author regarding the past performance and future prospects of INTELSAT (International Telecommunications Satellite Organization), the global, commercial, intergovernmental communications satellite cooperative. This effort is informed by two main sources. First, the author completed in 1987 a book-length treatment of INTELSAT commissioned by the Max Planck Institute for Foreign and Private International Law [Snow 1987b] as part of the institute's multi-volume treatment of law and economics in international telecommunications. Second, at the behest of INTELSAT in early 1988 the author undertook an economic assessment of various aspects of that organization's operation [Snow 1988a], with an emphasis on the relative merits of one or many international commercial systems and INTELSAT's strategies for coping with future competition from fiber optic cables and private commercial satellite systems.

Constraints of time and space make it necessary to be selective in summarizing the results of these exercises. The Max Planck volume will be used here primarily as a source of conceptual paradigms for evaluating INTELSAT's past performance, although it contains a quite general economic, historical, and legal treatment of the organization and includes the U.S. government's White Paper on New International Satellite Systems [U.S. Senior Interagency Group 1985; reprinted in Snow 1987b, pp. 161-200]. The consultant's report, while containing discussions of a number of economic issues germane to INTELSAT's operation, will be used mainly as a source of explicit recommendations for INTELSAT to follow in order to assure its economic and institutional integrity into the 1990s and the twenty-first century.

Section 2 is a brief overview of INTELSAT's history and major policy issues up to the present. Section 3 outlines five major alternative models or paradigms proposed by the author to account for INTELSAT's interaction with its economic, legal, political, technical, and institutional environment to date. In Section 4, recommendations are presented for ensuring INTELSAT's long-term financial and political viability.

2. Overview of INTELSAT's History and Major Policy Issues

Like most major telecommunications enterprises today, INTELSAT regards the prospect of competition, and the diversion of circuits from its traffic base, as a major challenge. Under pressure from the United States government and private satellite systems proposed by American entrepreneurs in cooperation with non-U.S. partner entities, INTELSAT has acceded to various instances of entry by allowing "coordination" of such systems under Article XIV(d) of its intergovernmental agreement, according to which separate international public systems shall not cause "significant economic harm" to the global system.

Competition was not an issue in INTELSAT's formative years, however. The novelty of its technology, the modest extent of its traffic streams, and the presence of economies of scale combined to create the presumption, before and during INTELSAT's creation and early years of operation, that competition would be economically inefficient and politically divisive. Instead, there were two major issues affecting INTELSAT's member states, signatory administrations, users, and suppliers through the 1960s and early 1970s. The first was reducing the degree of perceived U.S. dominance in the organization. This came in two forms: heavy U.S. usage of the system (over 60 per cent in the early years), translating into

American veto power over the organization's executive and policy body; and the dual role of the Communications Satellite Corporation (Comsat) as the U.S. signatory in INTELSAT and its manager (contracting business agent and executive) as well. The second major issue of INTELSAT's early years involved the distribution of contracts for the first four generations of INTELSAT satellites. European aerospace firms, backed by their governments, complained that they did not receive their "fair share" of these contracts, while American interests in INTELSAT and the U.S. aerospace community responded that the organization was obligated by treaty to award contracts to firms offering the best conditions of price, quality, and delivery. During the late 1960s and early 1970s such firms tended to be U.S.-owned, even in disproportion to the considerable extent of American usage and financing of the system.

In retrospect, INTELSAT succeeded in overcoming these initial challenges during the 1970s. This occurred because of the painstaking renegotiation of its permanent agreements and the steady development of the European and Japanese aerospace industries, which by 1980 or so were able to compete on an equal basis with American firms for INTELSAT subcontracts. It bears mention that all of INTELSAT's prime contractors to date have been U.S. firms, although the European spacecraft Ariane has been used for several launches.

The renegotiated intergovernmental and operating agreements ensured the rights and representation of smaller countries in the maturing INTELSAT organization. Safeguards against bloc or majority voting by larger INTELSAT members were provided. In addition, two new bodies--the Assembly of Parties uniting all member governments, and the Meeting of Signatories comprising all designated operating entities--were created and charged with discussing and resolving major policy issues on the basis of one vote per member. Comsat's

role as INTELSAT's manager was gradually phased out as INTELSAT built up a staff of over 600 international civil servants and constructed its own headquarters building in northwest Washington, D.C. Finally, the natural decline of the U.S. share of INTELSAT's traffic from over 60 per cent to its present level of about 25 per cent as the system grew attenuated early apprehensions about American dominance of the global system.

As it resolved the difficulties of its infancy and adolescence, INTELSAT faced new challenges and opportunities in assuming the status of an established international organization in the mid-1970s. The most important of these ongoing and still largely unresolved issues are the following [see Snow 1987b, pp. 83-129 for greater detail and references].

a. Separate systems [see Aronson and Cowhey 1985, 1988]--Beginning in 1983, several private U.S. firms organized to enter the international commercial satellite market. Ultimately Orion and PanAmSat obtained approval from the U.S. Federal Communications Commission (FCC) to do so. Orion later dropped out, but PanAmSat ultimately succeeded in finding cooperating foreign entities (Peru and possibly the United Kingdom as well--see Solomon and Walker [1988]); in obtaining INTELSAT coordination under Article XIV(d) in early 1987; and in launching its first satellite and beginning operation shortly thereafter. U.S. executive authorization, by way of a White House statement issued in November 1984, allows entry of private firms for intrafirm communications only. Thus, PanAmSat is not yet arguably engaging in "public international" telecommunications, although it has INTELSAT's authorization to do so. Nevertheless, more frontal assaults on INTELSAT's "core" traffic may be expected in the not too distant future.

b. Fiber optic cables--Most knowledgeable observers regard the numerous public and private initiatives in international, commercial submarine fiber optic cables now in design, construction, or operation as more potent threats to INTELSAT's financial integrity than competing satellite systems. Cables offer certain transmission advantages over satellites, and INTELSAT's treaties provide its members no sanctions against intermodal competitors. Furthermore, cables can be expected to span the same dense traffic routes along which INTELSAT competes for its busiest and most profitable connections.

c. The role of Comsat in INTELSAT--Comsat faces various challenges the solutions of which may pose difficulties for INTELSAT. For example, INTELSAT and the British government have permitted the British firm Cable & Wireless some measure of direct access to INTELSAT, and in so doing have bypassed British Telecom, the designated British signatory to the INTELSAT operating agreement and a competitor with Cable & Wireless in many domestic and foreign markets. The U.S. White Paper [U.S. Senior Interagency Group 1985, p. 32] likewise exhibits high-level U.S. sympathy for a policy allowing large U.S. users direct access to INTELSAT, thereby with the effect of bypassing Comsat, the U.S. INTELSAT signatory. In addition, protracted rate cases before the FCC and the perceived non-transparency of the costs that Comsat incurs and the prices it passes along to its users have not endeared Comsat to U.S. regulators, legislators, or users.

Comsat's response has been to attempt to diversify its activities and markets. One step in this direction was its proposed merger with the much larger firm Contel, a major independent U.S. telephone company. When the initiative failed, reportedly because of executive and legislative sentiment that such a move would be inconsistent with Comsat's continuing role in INTELSAT, the merger was called off. Bypass of Comsat by large U.S.

carriers would inevitably mean that Comsat would enter markets in at least oblique competition with INTELSAT. For example, Comsat recently announced its intention of investing in the TAT-8 transatlantic fiber optic cable now under construction.

d. Spillover to INTELSAT of domestic deregulation in its member countries--As a general rule, successful pressure for domestic liberalization of telecommunications regulation is followed by similar lobbying for relaxation of international telecommunications rules. In the United States, where this process is the farthest advanced, successful domestic deregulation in the decade or so preceding its publication led to the far-reaching and perhaps naively expectant arguments for international deregulation contained in the White Paper [U.S. Senior Interagency Group 1985].

Domestic deregulatory pressures of this nature can be expected to have similar effects on INTELSAT after an appropriate institutional lag. Potential (Comsat) and actual (British Telecom) bypass of INTELSAT signatories in domestic markets, for example, may well heighten sympathy for bypass of INTELSAT itself, whether by private satellite operators or fiber optic cables. In addition, the disaggregation of pricing policy and the realignment of prices and costs market by market that result from domestic deregulation may well dispose INTELSAT policy makers increasingly toward a more flexible pricing regime in that organization as an obvious means of meeting growing competition after two decades of monopoly operation and average-cost pricing. Such flexibility could require the amendment of its permanent agreements, although there is no consensus as to whether and how such a process should be undertaken.

e. Effects of limited launch capacity--Organized in an environment of few satellites and plentiful launchers, INTELSAT faces the opposite problem today. The roots of the

current undersupply of launchers lie in the much heavier demand for launches of military, scientific, domestic, regional, and private satellites, as well as the disheartening string of U.S. and European launch failures in 1986 and 1987.

Three factors, however, are mitigating the risks INTELSAT now faces in this area. First, conventional sources of supply (Ariane and the U.S. space shuttle) appear to have overcome earlier difficulties: witness the successful Discovery mission completed early in October 1988. Second, other launch providers in countries like Japan, China, and the Soviet Union are now in a position to offer commercial satellite launches to geostationary orbit. Finally, as the premier consumer of commercial launch services over a long period of time, and as an international organization comprising 114 member states, INTELSAT maintains excellent relationships with launch enterprises and can be expected to receive priority treatment in times of launch scarcity.

f. INTELSAT as an international organization--INTELSAT's chronological seniority has been accompanied by a commensurate maturation of its status among sister institutions. The renegotiation of its treaties, the acquisition of its own staff in lieu of Comsat personnel borrowed under a management contract, and the completion and occupancy of its new headquarters building have already been mentioned. A protocol on priviliges, exemptions and immunities entered into force in late 1980. In addition, INTELSAT has long-standing ties with other international organizations, particularly the International Telecommunication Union (ITU) and the United Nations. Although it cannot belong to the ITU since it is not a single sovereign state, INTELSAT and the ITU have for many years exchanged observers and in 1981 concluded a joint memorandum. Relationships with the United Nations have centered on periodic meetings of the U.N.'s Committee for the Peaceful Uses of Outer

Space. Finally, INMARSAT (International Maritime Satellite Organization), consciously organized along the lines of INTELSAT during the 1970s, presently leases INTELSAT capacity to supply some of its services. Memoranda of understanding exist between these two organizations, as well as between INTELSAT and the Asia Pacific Telecommunity, EUTELSAT, the Intergovernmental Bureau for Informatics, and the PTT ministry of the Soviet Union. INTELSAT is also a member of the Honolulu-based Pacific Telecommunications Council.

g. INTELSAT and developing countries--INTELSAT's voting and administrative structure, as renegotiated in its permanent treaties now in force for 15 years, accord its developing members, who constitute a sizeable majority of its adherents, certain advantages they would not enjoy under a private commercial regime. As users and co-owners of an international organization that is operated as a financial cooperative, for example, they are uniquely able to utilize INTELSAT as a forum for making known the particular needs of the developing world as they regard satellite communications.

A number of policies adopted by INTELSAT have helped its developing members. First, the overall practice of average-cost pricing has protected them from some of the harsher pricing realities that would result from the disaggregation of tariff policy and the alignment of costs with prices service by service. Second, long-term leases of INTELSAT transponders (and half and quarter transponders) for domestic service have been available to all INTELSAT members since the early 1970s. Finally, in recent years INTELSAT has introduced numerous demonstration, aid and training programs which again have primarily involved its developing members. Among these projects are VISTA, a low-density telephone service, and Project SHARE, which involved some twenty projects in forty-four countries,

including an ambitious and highly successful tele-education demonstration in the People's Republic of China. It is possible that INTELSAT policies and projects benefiting the developing world would be endangered if INTELSAT felt obliged to compete aggressively with private systems intent on drawing away its densest and most remunerative traffic streams.

3. Alternative Models for Evaluating INTELSAT

Five alternative but often overlapping paradigms suggest themselves as ways in which INTELSAT's past behavior, present challenges, and future prospects can be fruitfully and insightfully assessed. These are presented below with minimum discussion. For more references and greater detail the reader is referred to Snow [1987b, pp. 131-143].

a. Functionalist theory--According to functionalists, international cooperation of a technical, non-controversial, and apolitical nature can expand in scope so as gradually to displace conflict-generating activities among nations [see Haas 1964]. Functionalism emphasizes not only such activities themselves but also the institutional matrix in which they are accommodated. Pelton [1974] first interpreted INTELSAT in such a framework.

In the broad and diverse arena of international relations and institutions, INTELSAT has certainly played a relatively technical and apolitical role. This can be attributed to the universally beneficial nature of the technology it is organized to exploit, the commercial nature of its mission, its financially cooperative structure and operation, and the care and wisdom with which its treaties were negotiated, first in the mid-1960s and later, under quite different circumstances, in the early 1970s.

Ultimately, of course, INTELSAT has been forced to confront potentially divisive political and distributional questions. The first to surface, as noted earlier, addressed U.S. influence in the organization and the allocation of subcontracts to the aerospace industries of various member countries. Presently, INTELSAT's accommodation of competitive thrusts from fiber optic cables and privately owned satellite systems raises issues of distributive equity and economic efficiency within the organization and in the broader international community. Yet its primary identification as the world's only international organization with a commercial, technological mandate has allowed it to enjoy a degree of engagement in technical activity and a measure of detachment from the sharper political issues and decisions that are the daily fare of bodies such as the United Nations, the European Community, the World Administrative Radio Conferences, and the General Agreement on Tariffs and Trade.

Nevertheless, the functionalist framework is incomplete and somewhat one-dimensional. In recent years INTELSAT has increased in both its technical expertise, operational breadth, and exposure to political conflict. Richer explanatory structures are needed.

b. Cooperation and social economy--Two converging trends of thought can be identified under this rubric. First, political and economic cooperation, it has been argued [see Voge 1986], is often superior to the competitive marketplace. Benefits of cooperation are seen to include smaller risks of a proliferation of protocols and technical standards; less anticompetitive collusion by large firms; and greater effectiveness in decentralizing telecommunications and the media.

The second view to be noted has evolved from the experience of British cooperatives and the insights of German economists and political philosophers during the nineteenth century. Generically known as social economy, it has recevied its most careful and complete intellectual elaboration in West Germany, where it is known as Gemeinwirtschaftslehre. Social economy provides arguments for retaining the state as the major provider of important infrastructural services in sectors such as telecommunications, transportation, energy, health, and education. In most modern interpretations of Gemeinwirtschaftslehre, state entrepreneurial activism is seen as a "stopgap" solution when the competitive market fails to provide goods or services to the satisfaction of the "public interest" or "common good" [Snow 1988b].

The views of a modern adherent of social economy [Thiemeyer 1970, 1983] are illustrative. He argues, for example, that telecommunications liberalization lacks the benefits attributed to it by neoclassical economic theory. He not only rejects marginal cost pricing, but also opposes any linkages of prices with costs, for example by regulatory rules, due to the econometric difficulties in estimating costs and the large bureaucracies which inevitably formulate and enforce pricing rules. In addition, cross-subsidization patterns, an element of any politically negotiated tariff structure, are seen as an effective method of realizing various social goals, such as "regional equalization of burdens," to benefit groups or geographic areas deemed as disadvantaged.

As noted, INTELSAT is both a financial cooperative of investors and users and an intergovernmental body with an operational mandate. In its early years of operation, it was indeed a "stopgap" in a market in which no private entrepreneurs stepped forward. This has, however, changed rapidly and dramatically during the past five years. Accordingly, the

insights of cooperation theory and social economy seem more appropriate to the earlier stages of INTELSAT's operation.

c. Political economy of deregulation--This approach has the merit of taking into explicit account the political environment in which regulation occurs. It addresses a basic question, first examined by Olson [1982], which can be stated as follows: How are small, tightly organized interest groups able to frustrate the enactment of changes in law, regulation, or public administration that would demonstrably increase aggregate social welfare? How do such groups acquire and maintain power? What arrangements are possible to effect a beneficial change by subsidizing overall losers with part of the benefits received by the winners?

Noll [1983, 1986], Noll and Owen [1983], and Derthick and Quirk [1985] have examined this complex of issues in the context of telecommunications regulation in the United States and other countries. In particular, Derthick and Quirk, discussing the U.S. deregulation of the 1970s and 1980s, emphasize the ability of the "politics of ideas," often through the patient and astute advocacy of government, academic, and business economists, to act as a countervailing force against the generally harmful interest-group tactics that Olson examined.

The political economy of deregulation paradigm has until now been applied primarily to domestic regulatory situations, and has not yet found use in international relations or organizations. Snow [1987b, pp. 137-139], however, suggests a way in which INTELSAT can be fruitfully examined from this point of view.

First, INTELSAT's "interest groups" must be identified. Happily, the cooperative structure and broad consensus expressed in its treaties and adhered to by its 114 member

states make it difficult to detect clear and lasting cleavages within the organization. The renegotiation of new agreements, and their entry into force in 1973, effectively eliminated many long-standing conflicts, as has already been noted. One enduring issue, however, reflecting global political and economic realities outside the organization, is that of the industrialized world's attitude toward developing countries.

Second, the dynamics of this conflict should be elaborated and analyzed within INTELSAT. An obvious tradeoff is presented to the organization by the rather divisive separate systems issue it has faced since the early 1980s. Assuming that INTELSAT coordinates separate private systems under Article XIV(d), as it has already done, and that it must offer more favorable, price-based tariffs to its large users to prevent erosion of traffic to such systems, how much will this hurt its developing member countries who in the past have benefited, through such programs as VISTA and Project SHARE, from the subsidy element in INTELSAT's statutory average-cost pricing? Assuming that this analysis of winners and losers is fundamentally correct and can be reasonably quantified, is the change on the whole beneficial to INTELSAT? If so, what mechanisms or political incentives exist to compensate the losers with part of the gains realized by the winners? If not, how can aggregate losses be minimized and equitably shared?

d. Collective or public goods model--Martinez [1985] has outlined elements of a model focusing on INTELSAT's use of the radiofrequency spectrum and geostationary orbit. He sees the former as a collective or public good because of its indivisibility and nonexcludability, meaning that it would be difficult, inefficient, or perhaps impossible for private, unregulated markets to provide access to the spectrum. The geostationary orbit, by contrast, is not a collective good, being both divisible and excludable.

This asymmetry between spectrum and orbit is seen by Martinez as upsetting the careful calculus of nations in reducing the tension "between a state's perceived need to cooperate and its instinctual guarding of sovereign prerogatives" [Martinez 1985, p. 150]. In particular, the machinery of the ITU and the U.N. Outer Space Treaty are better equipped to handle claims to the spectrum than to the geostationary orbit.

In addition, the "free rider" problem inherent in INTELSAT (exclusion of non-contributors from enjoying its benefits) is, due to new technology, not present in so great a degree in dedicated regional, national, or private systems. Technology, then, is seen as converting certain types of satellite systems into private goods and making them in some sense preferable to INTELSAT, which is still saddled with "free rider" and other collective goods problems.

A number of alternatives exist to counter this trend. Regionalization of INTELSAT and a disaggregation of its pricing structure would tend to reduce the problematic collective goods nature of its economic and technical structure. In addition, scholars such as Levin [1984] have outlined principles, procedures, and models for auctioning or otherwise exchanging rights to use the spectrum and orbit under conditions approximating those of an unregulated private market. All of these alternatives, assuming the merits of the collective goods approach, are useful ways of forestalling "a disintegration of INTELSAT into a plethora...of smaller, less efficient satellite systems" [Martinez 1985, p. 159].

e. Neoclassical economics--This widespread method of economic analysis emphasizes the optimization (maximization or minimization) of key economic variables such as profit, cost, revenue, and utility, subject to constraints described by various economic indicators, such as inputs, prices, costs, and consumer preferences.

INTELSAT has been analyzed at length from this perspective. For example, an early study of INTELSAT [Snow 1976] concluded that during INTELSAT's first decade its behavior was consistent with the hypothesis that it was maximizing the welfare of consumers of international satellite services, at least subject to the constraint of average-cost pricing that its agreements seemed to impose. This conclusion was based on a detailed consideration of INTELSAT's cost structure, tariff policy, technology, resource use, and market interaction with possible rivals. Another study [Snow 1975] concluded that INTELSAT's behavior in satellite design and launch timing accorded with optimizing behavior derived from a model designed to minimize the present discounted cost of launching, at equally spaced intervals, satellites sufficiently large to satisfy exponentially growing demand given economies of scale in production and depreciation of in-orbit capacity.

More recently, the application of new theory in the area of natural monopoly and its sustainability [for conceptual and bibliographic background see Bailey and Friedlaender, 1982; Baumol, Panzar, and Willig 1982; and Sharkey 1982] has indicated, using an econometrically derived two-output cost function for INTELSAT, that the organization has enjoyed natural monopoly (essentially, mulltiproduct economies of scale) during the period 1967-84 [Snow 1987a, 1987c]. In addition, recent, more focused study has used neoclassical economic methods to determine the cost savings of extending satellite lifetimes; efficiencies of a single system as opposed to several smaller systems in restoring service following spacecraft outages; and economic incentives for breaking away from a single global system [Snow 1988a].

A number of qualifications have been suggested for neoclassical analysis in telecommunications as elsewhere. These involve, for example, political and econometric difficulties involved in marginal-cost and usage-sensitive pricing; external price effects (externalities); missing or inaccurate data; mitigating political and sociocultural considerations; and the difficulty of arriving at a single indicator of social welfare. Nevertheless, it appears that of the five explanatory paradigms presented here, neoclassical economics affords the richest theoretical insights into INTELSAT's operation, and that refinements and qualifications to this approach can best be handled within rather than outside of its structure.

4. Recommendations for INTELSAT's Future

In the extensive study [Snow 1988a] commissioned by INTELSAT and undertaken to examine the economic realities in which it operates, the following recommendations were made in the interest of assuring INTELSAT's growth and financial viability into the twenty-first century. They are reproduced here, with some modifications, directly from that document.

Recommendation #1--As a matter of priority, INTELSAT should investigate the benefits to be derived from pursuing a broader spectrum of pricing policies, particularly in the direction of demand-sensitive tariffs. Variants of such pricing can assure the sustainability of INTELSAT's natural monopoly over a broad range of conditions. Otherwise, INTELSAT runs the very real risk of presiding over an unsustainable natural monopoly. This would provide specialized, smaller systems with incentives to compete away much of INTELSAT's traffic while increasing the overall cost of services to INTELSAT's

remaining users. Legal and policy analysis as appropriate should address the modalities of revising INTELSAT's agreements to allow greater leeway in tariff policy and more significant departures from the benchmark of average-cost pricing.

INTELSAT's greater pricing latitude should be wielded more aggressively in competing with separate domestic, regional, and international systems that threaten to divert its traffic to the detriment of most or all user groups. Furthermore, tariff options other than demand-based pricing abound. For example, INTELSAT could offer 10- or 15-year leases of moderately sized satellite carrier components, say on the order of 4.5 mHz. Offering long-term leases of efficiently configured satellite communications capacity would provide cost savings and tariffing advantages that would make INTELSAT more effective in competing with separate systems.

Recommendation #2--INTELSAT should quantify and more vigorously market its considerable advantages in providing global service; in maximizing its "network effect" relative to smaller systems; and in providing swifter and surer restoration of interrupted service by using its larger arsenal of in-orbit spacecraft.

Recommendation #3--INTELSAT should maintain its broad spectrum of services and programs that benefit primarily its developing members. Although these activities certainly involve a subsidy component, the economic losses from such cross-subsidies are undoubtedly quite modest when compared to the poor publicity and loss of good relationships with its majority of developing members that would result if a real or perceived diminution of its development-oriented activities occurred. Financing questions in particular are an important and insufficiently appreciated aspect of introducing state-of-the-art global telecommunications to developing countries. The private market may be unable or unwilling

to service the limited quantity and complex nature of the needs exhibited by new or prospective INTELSAT members as they contemplate usage of the global satellite system.

It bears noting that INTELSAT's developed members also have a significant stake in seeing the organization's developing members improve their satellite communications. For example, only 5 to 10 per cent of INTELSAT's traffic flows between developing countries. The rest is either between developed and developing countries, or between developed countries exclusively. More generally, a prerequisite to mutually beneficial international trade and investment is the marketization of all sectors of a nation's economy, and its access to high-quality telecommunications links both domestically and internationally.

Recommendation #4--INTELSAT should thoughtfully consider the economies of scope advantages it could realize by introducing various more specialized services among its tariffed offerings. These could include aeronautical satellite services; maritime services, in cooperation with INMARSAT; and non-synchronous applications such as weather or earth resource services. There is every evidence that the cost complementarities and technological synergies from joint provision of these services would more than outweigh any economies of scale that individual specialized providers might enjoy in offering them separately. As in the case of pricing innovations, legal and policy analysis should consider the extent, if any, to which INTELSAT's agreements must be revised in order to accommodate a broader range of service offerings.

Recommendation #5--INTELSAT should carefully investigate the possibilities of extending the lifetime of its satellites. Analysis shows that modest but pervasive cost savings on the order of 10 per cent could be realized by doing so, other things being equal. Important dimensions of this decision involve whether the extension assumes current

technology or future technology (e.g., a new generation of longer-lived satellites); the percentage of satellites to be ultimately extended, and the pace at which the extensions will take place; and the precise technical, accounting, and stochastic meaning of satellite "lifetime." The latter will have important implications for the depreciation policy to be adopted.

Recommendation #6--To combat information purporting to show that INTELSAT's costs are significantly higher than those of domestic U.S. systems, INTELSAT should examine the incommensurabilities involved in such comparisons. This involves both the juxtaposition of different kinds of costs, such as the comparison of INTELSAT's average costs with the marginal costs of competitors; and the failure to take into account the full range and quality of services provided by INTELSAT. Conclusions reached should be made available in suitable form to users contemplating new usage of separate systems or the diversion of existing INTELSAT traffic to separate systems.

Recommendation #7--INTELSAT should effect tighter conceptual and administrative links between the various components of its strategic planning. These can be outlined as follows [see Snow 1987b, pp. 32-34]. Demand for services is an input to the provision of facilities via the facilities planning process. Facilities (output, capacity) give rise to costs that are specified by a cost function. Costs are related to prices by means of tariff policy; and prices are related to demand by demand functions. To the extent that INTELSAT conceptualizes and exploits these circular interrelationships of capacity, costs, prices, and demand, it will be able more completely to increase the value of the global satellite system to its investors; to become more cost effective; and to strengthen the natural monopoly properties it possesses.

Recommendation #8--INTELSAT should continue and intensify its analysis of various mathematical models affecting its operation, both to identify its own interests and to make its superior cost and service qualities better known to its users and potential users. The most important such models are those involving the re-estimation of INTELSAT's natural monopoly properties; clarification of INTELSAT's advantages in elasticity-based pricing; further investigation of economies of scope; equal spacing of satellite launches; parametric and sensitivity analysis of various models; and system-wide optimization and planning, involving the conceptual integration of INTELSAT's space segment and the users' ground segment.

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